Improved System Performance and Reduced Cost of a Fuel Reformer, LNT, and SCR Aftertreatment System Meeting Emissions Useful Life Requirement

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Eaton Corporation

2010 DOE DEER Conference

Detroit, MI

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Agenda

- **Introduction to Eaton Aftertreatment**
- **System cost reduction**
- **Durability demonstration of cost reduced system**
- **Fuel doser and system packaging**
- **Summary**

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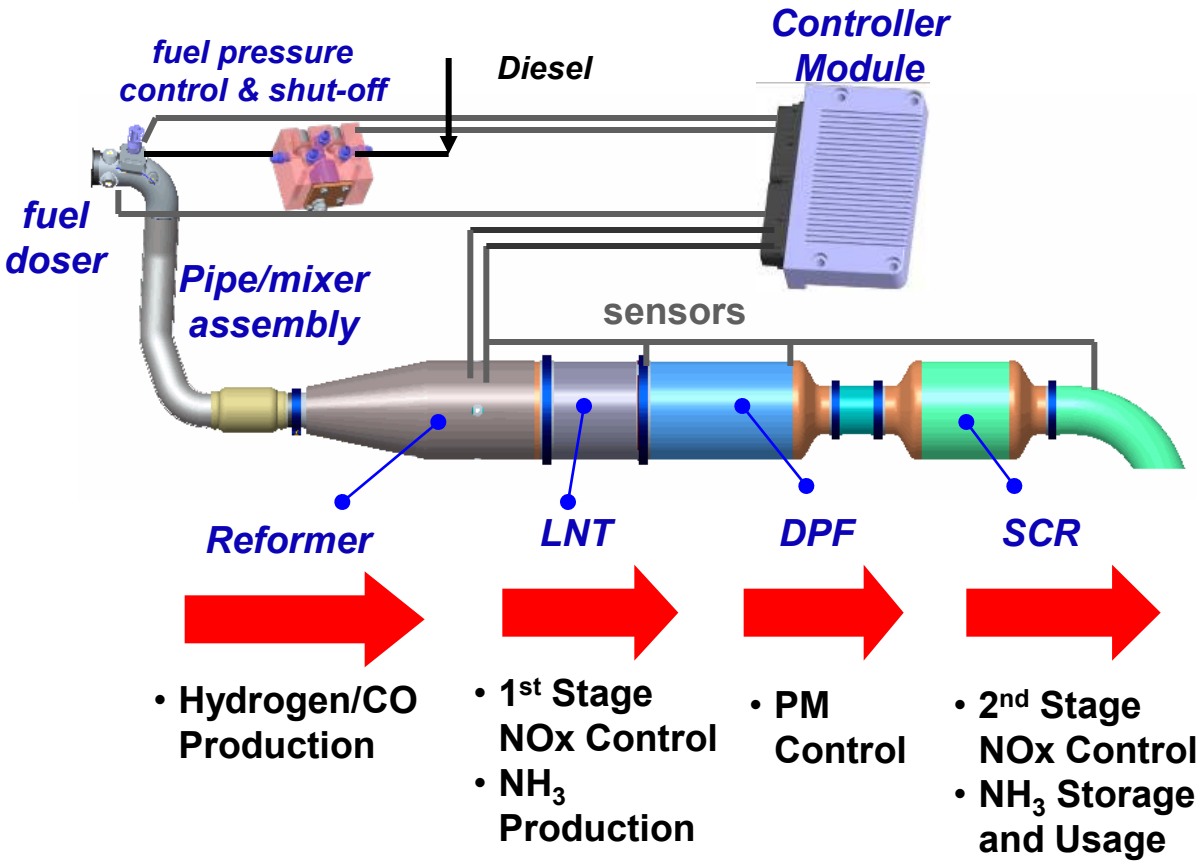
Introduction
Eaton Aftertreatment System



LNT – Lean NOx Trap

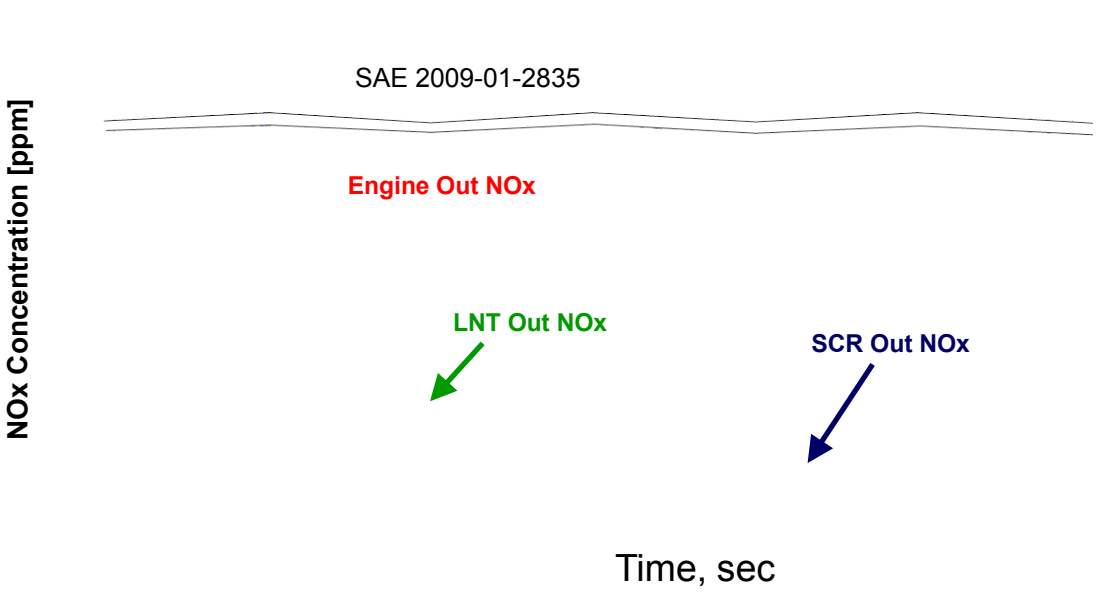
SCR – Selective Catalytic Reduction

DPF – Diesel Particulate Filter

How it Works:

- Engine NOx is reduced by the Lean NOx Trap (LNT) and Selective Catalytic Reduction (SCR) catalysts.
- The LNT stores NOx and undergoes controlled periodic regeneration, releasing the NOx as nitrogen and NH_3.
- The SCR collects the released NH_3 and uses it to continuously treat the remaining NOx.
- A Diesel Particulate Filter (DPF) traps Particulate Matter (PM) and undergoes periodic regeneration.

Introduction
Typical Performance



- Proven Vehicle Performance
  - Tens of thousands of miles of EAS operation on MD and HD vehicles
  - Fuel consumption as low as 1.3%
  - Consistent NOx reduction performance meeting EPA 2010 standards
  - No vehicle drivability issues

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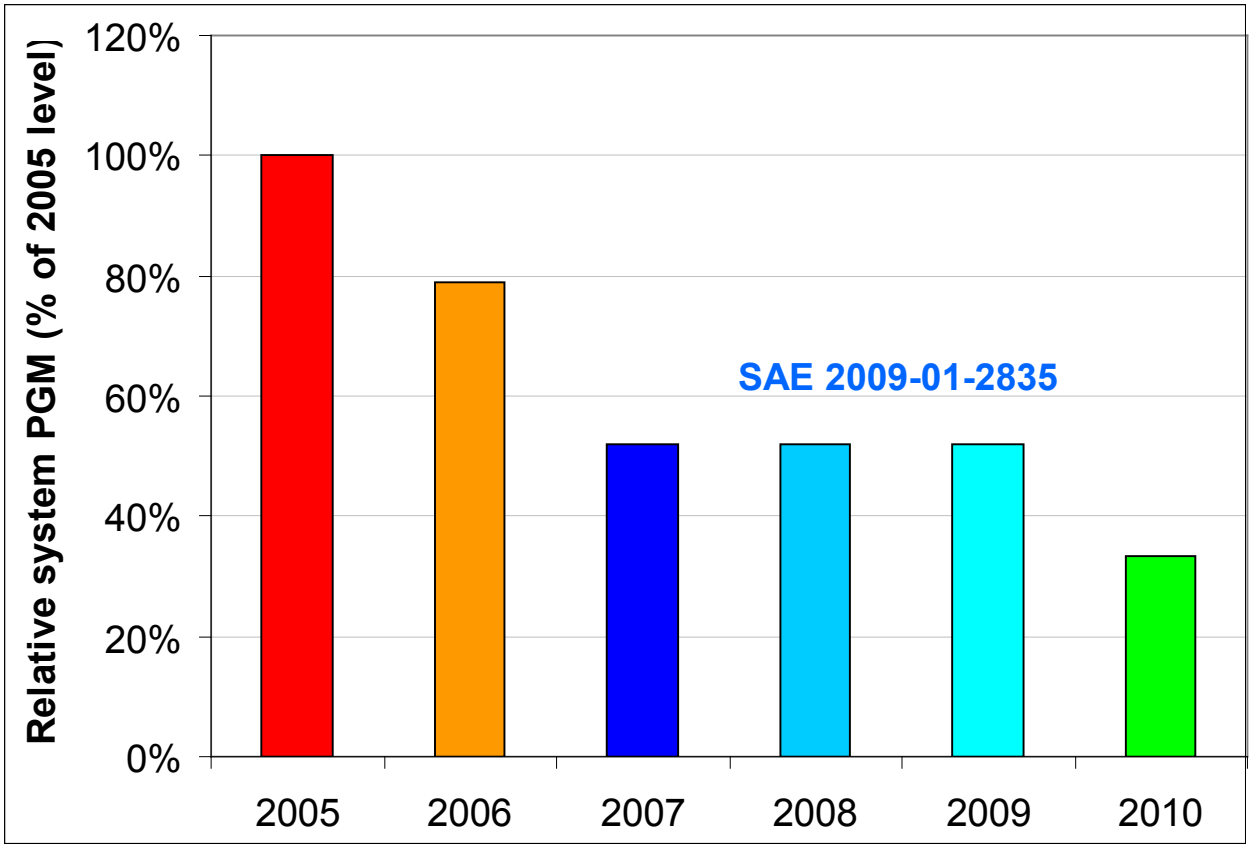
System Cost Reduction
Relative PGM Cost vs Time



PGM reduction in the Reformer, LNT and DPF

PGM cost of the 2010 system is 36% lower than previous publication

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Durability
Aftertreatment Durability Aging

System Configuration
- Fuel doser, Fuel reformer, LNT, DPF, SCR

Sulfur Loading Assumptions
- Total Sulfur in exhaust: 12 ppm on a fuel basis
  - 7 ppm from diesel fuel & 5 ppm from oil

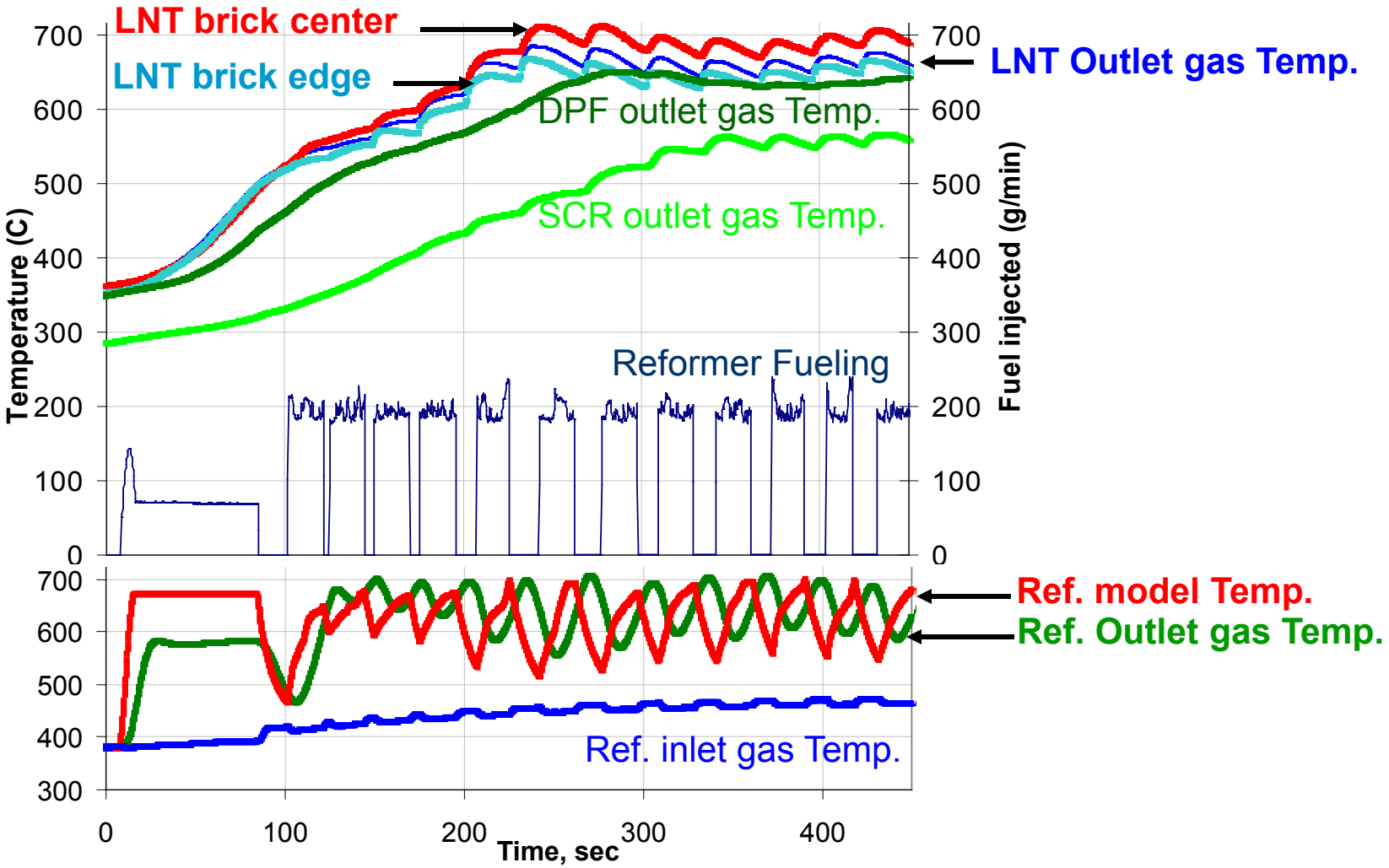
Triggered DeSOx Event: 0.5 g/L Sulfur on LNT
- LNT Sizing: 1.5 times engine displacement

Off-Highway Analysis
- 500 DeSOx events required - 8000 hour useful emissions life
  - One DeSOx event every 16 hours

On-Highway Analysis - Medium Duty Vehicles
- 225 DeSOx events required - 185,000 miles useful emissions life
  - One DeSOx event every 822 miles

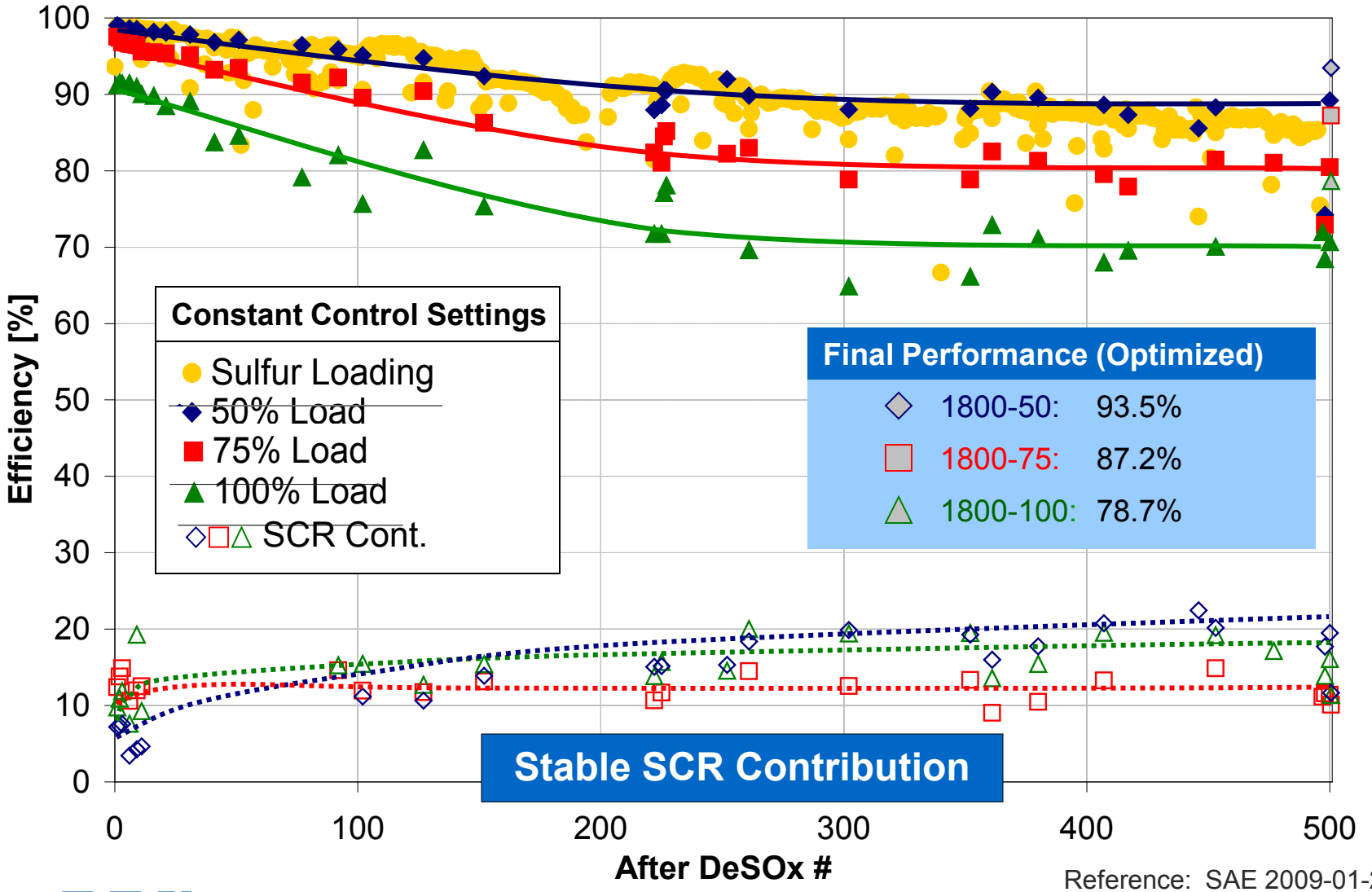
On-Highway Analysis - Heavy Duty Vehicles
- 500 DeSOx events required - 435,000 miles useful emissions life
  - One DeSOx event every 870 miles

System Control - Desulfation
Reformer and LNT Temperature Control



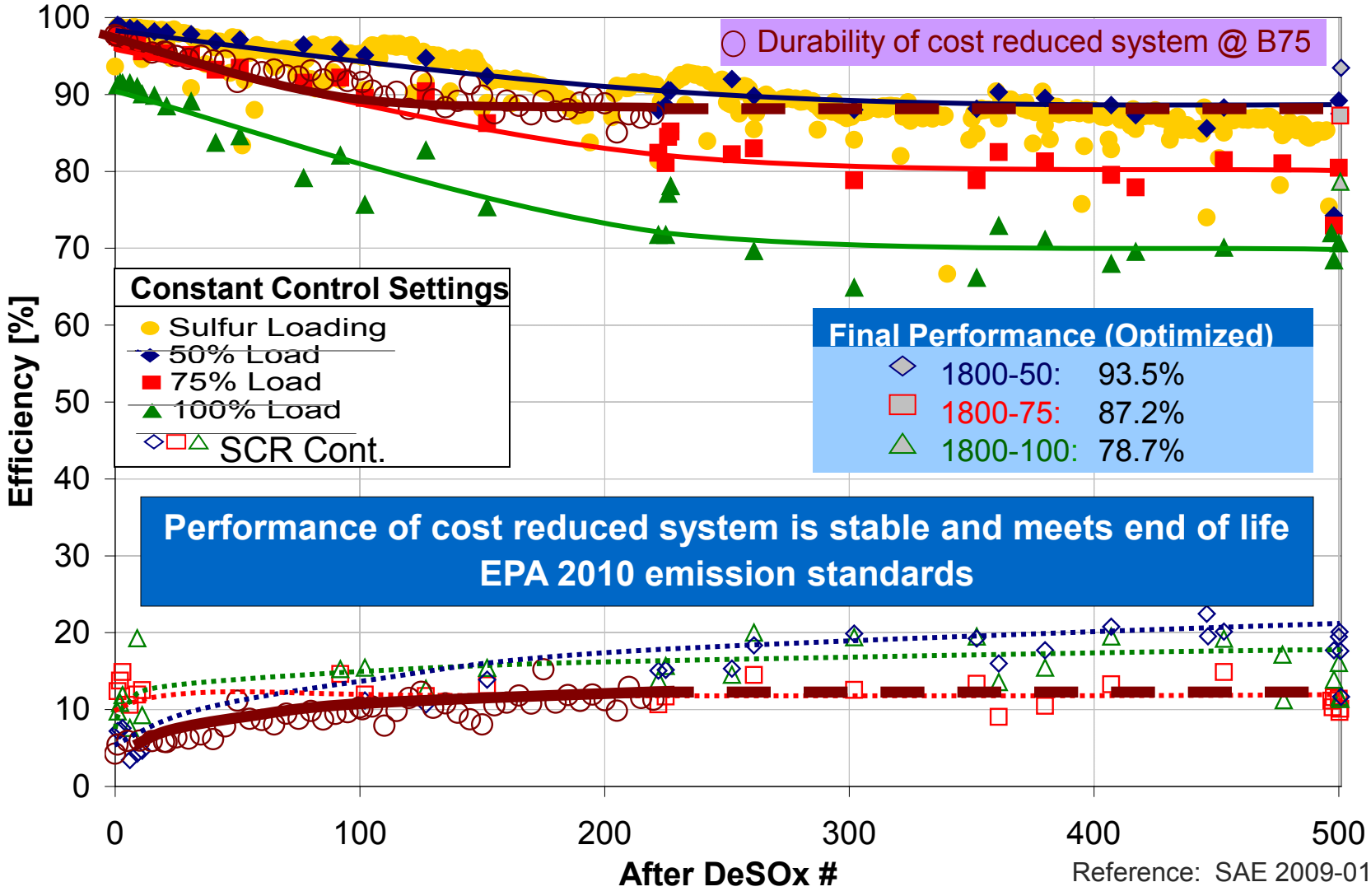
ECU accurately controls reformer/LNT temperatures

Durability – 500 Desulfation Events
Previous End of Life Aging



Reference: SAE 2009-01-2835

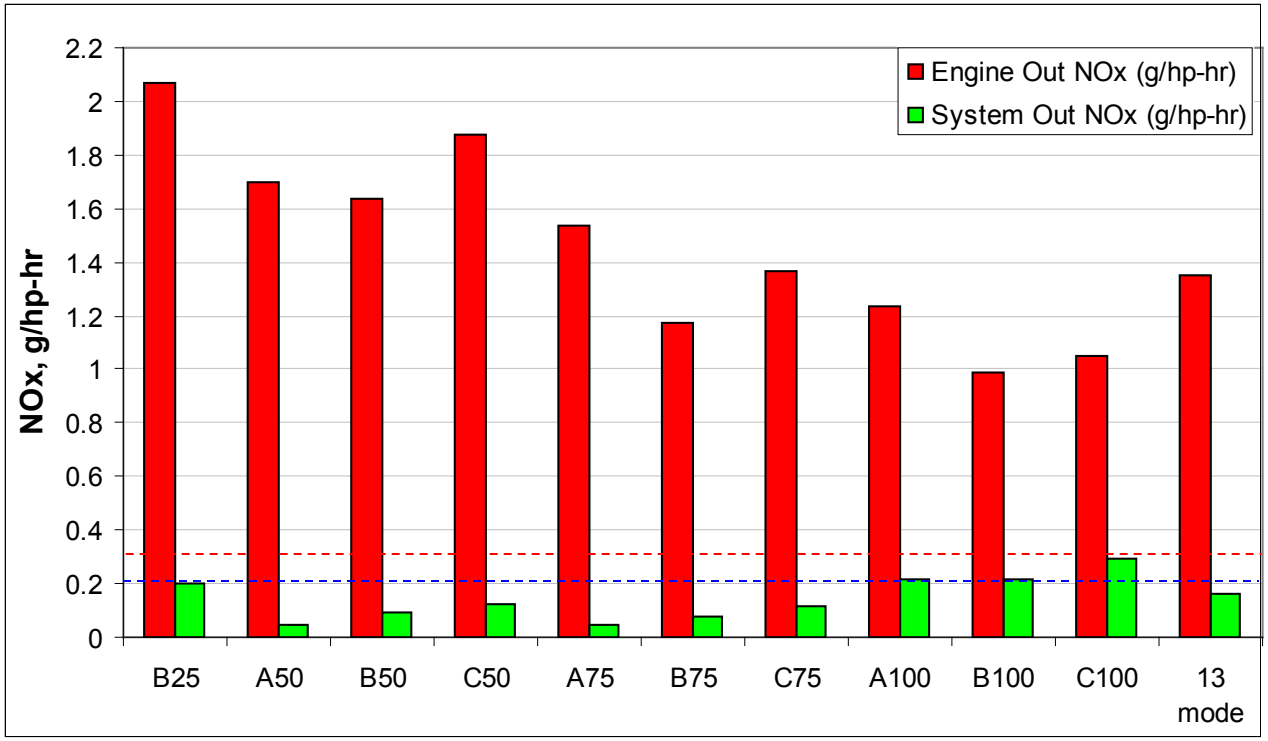
Durability – Comparison with Cost Reduced System
NO_X Reduction Efficiency



Reference: SAE 2009-01-2835

Added EATON-2010 Data

Cost Reduced System – Emission Results
Performance Under Various Modes



NTE limit

System out NOx meets EPA 2010 emissions standards

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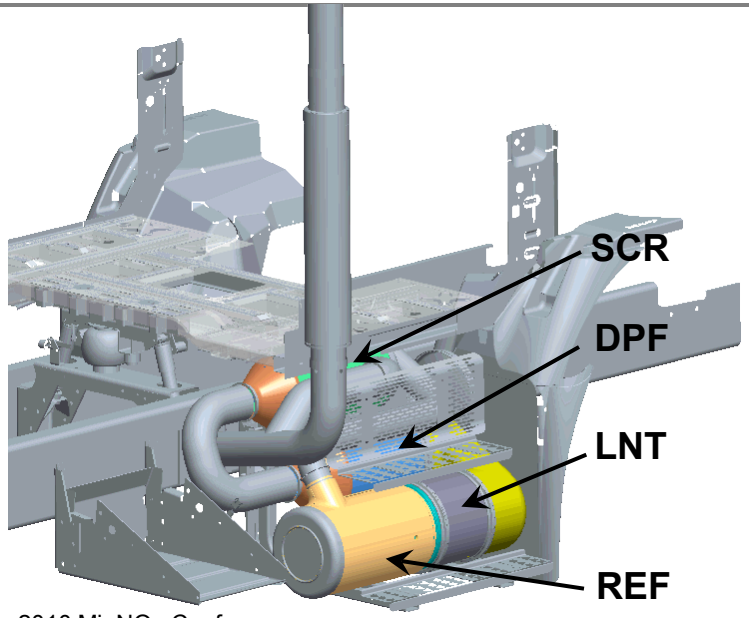
Fuel Doser
Improved Spray Quality

- Early injectors showed a small cone angle with large drop diameters
- Improved injector shows larger cone angles having smaller drop sizes
- Smaller droplets yields better mixing in a smaller volume

← Early injector (poor atomization with larger droplets)

Optimized injector (improved atomization & smaller droplets) →

System Packaging
Efficient Packaging



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REF – Reformer

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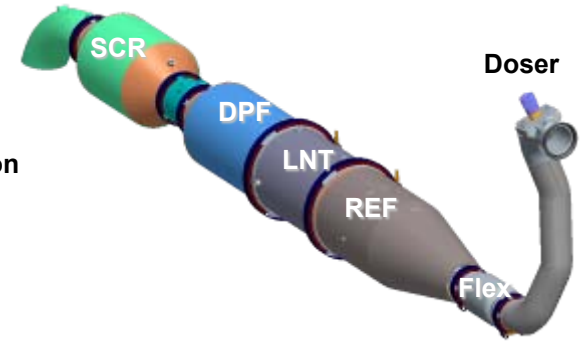
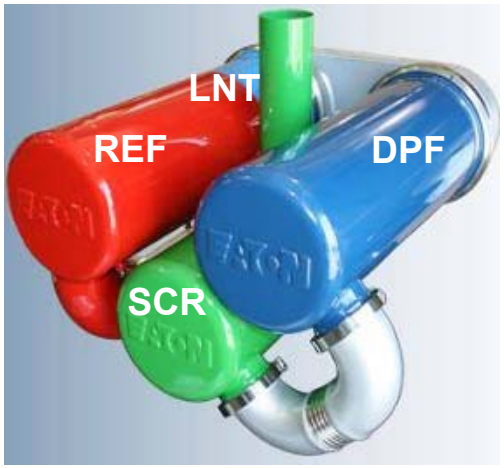
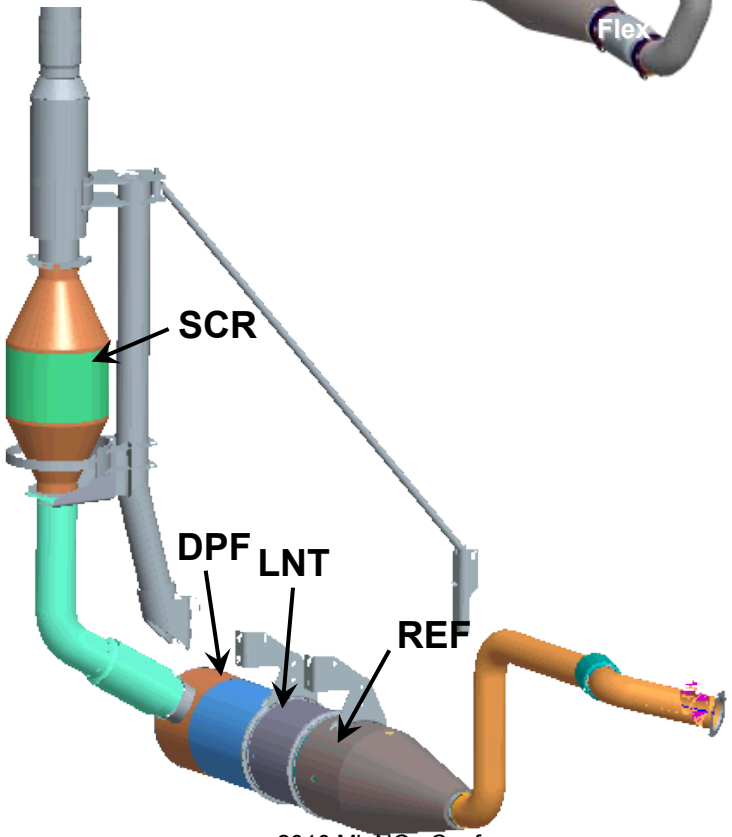


Improved mixing for compact packaging





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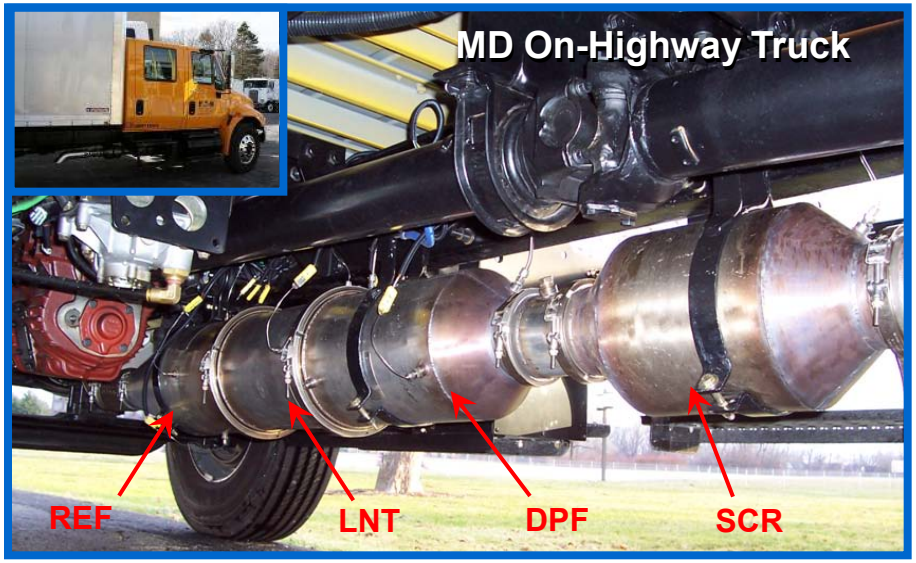
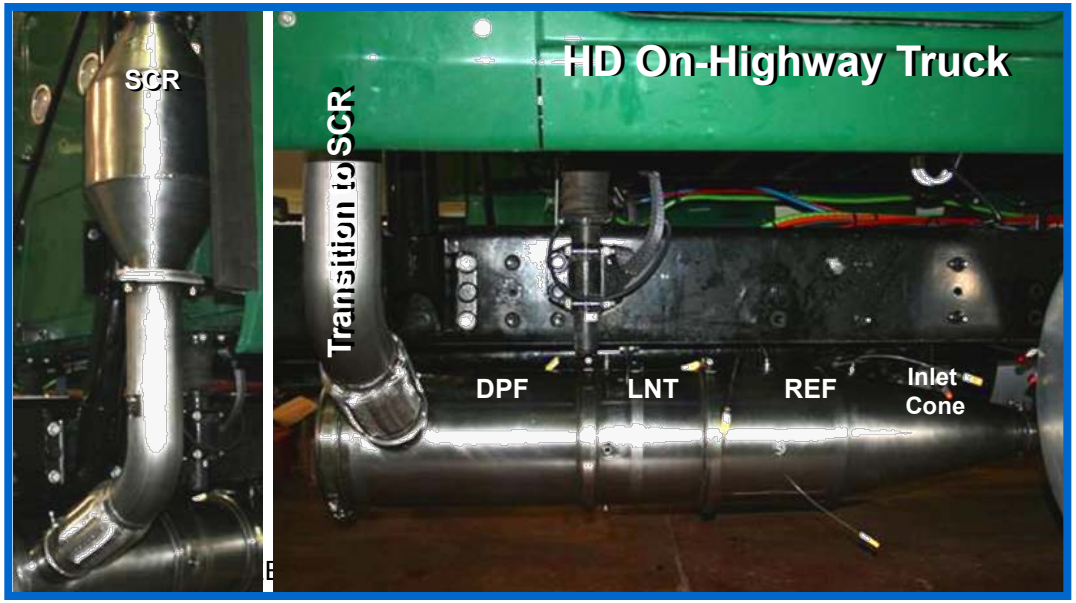
System Packaging
Application Examples





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- Demonstrated durable system performance that meets EPA 2010 on-highway emission standards
- System PGM cost 36% lower than previously published durability results
- Flexible and compact packaging options to meet OEM needs

Acknowledgements

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